
Chapter 17

Earthwork

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17.1 Objectives

- Learn the procedures for calculating earthwork quantities with GEOPAK
- Learn how to use Project Manager to set up and process an earthwork run.

Definitions

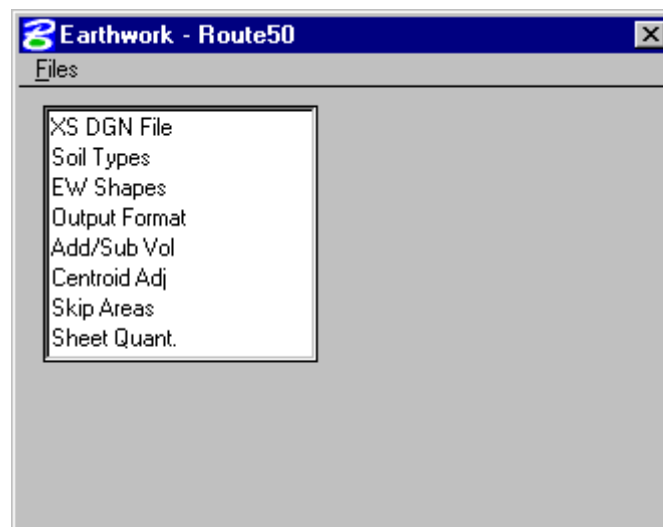
GEOPAK forms **earthwork shapes** in a design cross section .dgn file to represent the end areas used to calculate volumes. These shapes are created when the designer processes an earthwork run in which the existing ground, finished grade, base, etc. are identified by level, color, weight and type. For complete information, see the *GEOPAK Manual* or online help.

17.2 Accessing

To access the necessary dialogs needed to create and process an earthwork run, select **Project Manager >> Earthwork**.

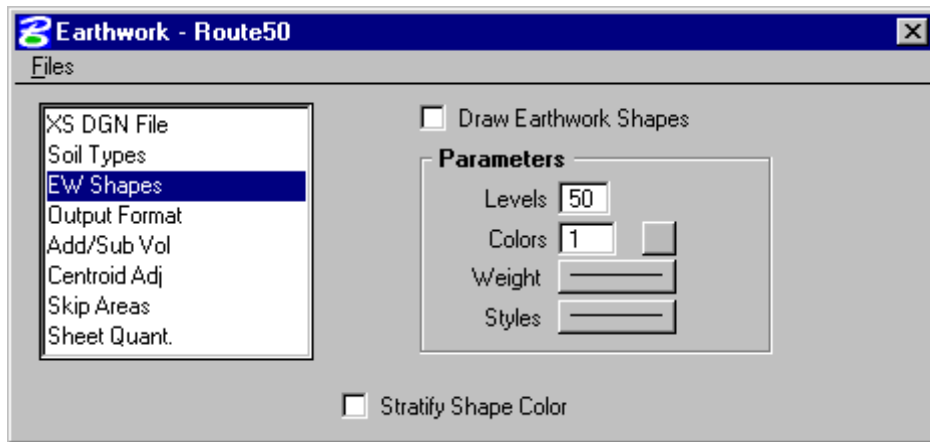
17.3 Dialog

Once the Earthwork run is chosen, the following dialog box appears.



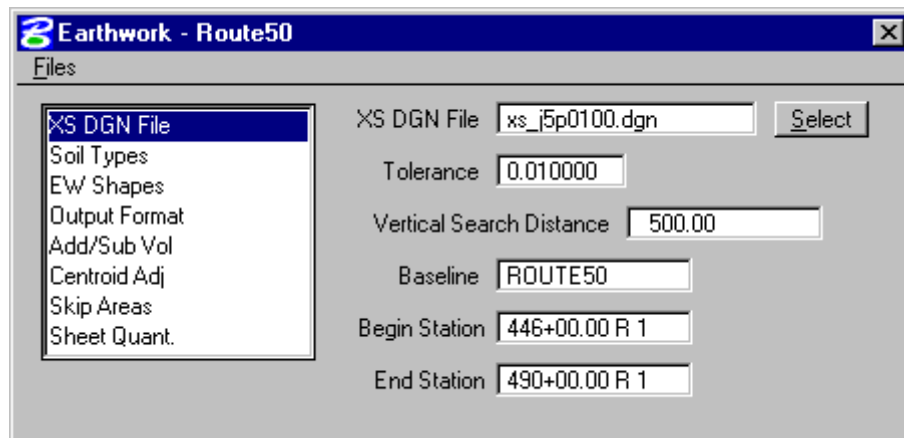
The left side of the dialog contains the list of parameters required to compute earthwork. When each parameter is selected, the dialog changes the keyin fields to reflect the selection. For example, when **EW Shapes** is selected, the dialog changes as illustrated below.

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17.3.1 XS DGN File

In **XS DGN File** the user can specify the file name in which to find the cross-sections.



Tolerance specifies the maximum distances between two elements to be considered as adjoining.

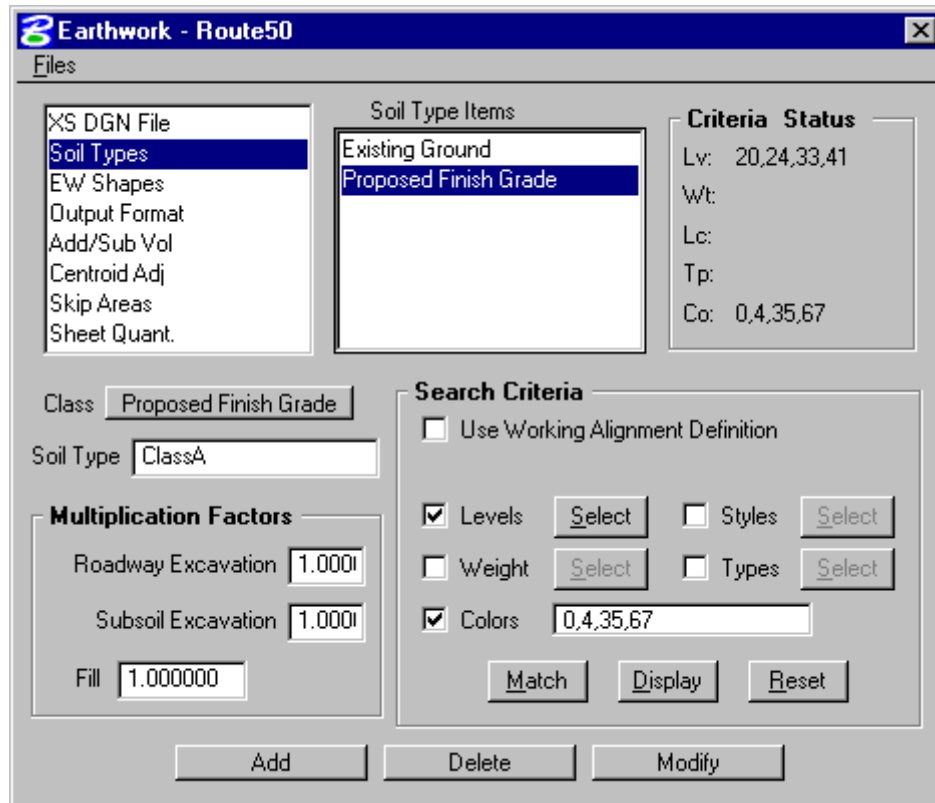
Vertical Search Distance specifies the distance above and below the cross-section to look for elements pertaining to that cross-section. **(DO NOT CHANGE!)**

Baseline specifies the Geopak COGO chain the cross-sections are based from.

Begin/End Station specifies the beginning and ending stations to perform the earthwork calculations.

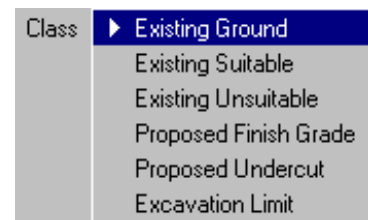
17.3.2 Soil Types

The **Soil Types** dialog requires the user to define the symbology and shrinkage/swell factors to be used in defining each soil type.



The user must first select the **Class** of the soil type. The classifications are as follows.

Existing Ground – identifies the surface of the existing ground. This classification is required to calculate earthwork.



Existing Suitable – identifies material that is to be removed, but can be used for fill material. (I.e. rock)

Existing Unsuitable – identifies material that is to be removed, but cannot be used for fill material. (I.e. shale, muck, pavement, etc.)

Proposed Finish Grade – identifies the surface of the proposed roadway. This classification is required to calculate earthwork.

Proposed Undercut – identifies proposed layers that are not part of the finish grade. This soil type is not the material being removed, but what the area will be backfilled with. (I.e. rock blanket)

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Excavation Limit –identifies the location to stop removing the existing suitable or unsuitable material. Excavation limits can also be used to separate the areas of earthwork calculations for staged construction, multiple roadway cross sections, etc.

Once the **Classification** is chosen, a **Soil Type**, the element symbology of the material, and the shrinkage/swell factors need to be entered. A **Classification**, except **Existing Ground**, can be listed multiple times. The **Soil Type** determines how the cut and fill are calculated. For example, a user creates an earthwork run with a classification of Existing Ground with a soil type of Existing, classification of Proposed Finish Grade with a soil type of Suitable_Grading, and a classification of Proposed Undercut with a soil type of Pavement. The output from the run would look as follows.

Station	Material Name	End Areas (square feet)	Unadjusted Volumes (cubic yards)	Adjusted Volumes (cubic yards)	Mult Factor	Mass Ordinate
449+00.00	SUITABLE_GRADING					
	Excavation	0.00	0	0	1.00	
	Fill	132.61	439	439	1.00	2887
	PAVEMENT					
	Excavation	0.00	0	0	1.00	
	Fill	315.81	960	0	0.00	2887
	EXISTING					
	Excavation	278.57	855	855	1.00	
	Fill	0.00	0	0	1.00	3541

In the same example, if both classifications of Existing Ground and Proposed Finish Grade had the soil type of Suitable_Grading, then the output would look as follows.

Station	Material Name	End Areas (square meters)	Unadjusted Volumes (cubic meters)	Adjusted Volumes (cubic meters)	Mult Factor	Mass Ordinate
449+00.00	SUITABLE_GRADING					
	Excavation	278.57	855	855	1.00	
	Fill	132.61	439	439	1.00	3541
	PAVEMENT					
	Excavation	0.00	0	0	1.00	
	Fill	315.81	960	0	0.00	3541

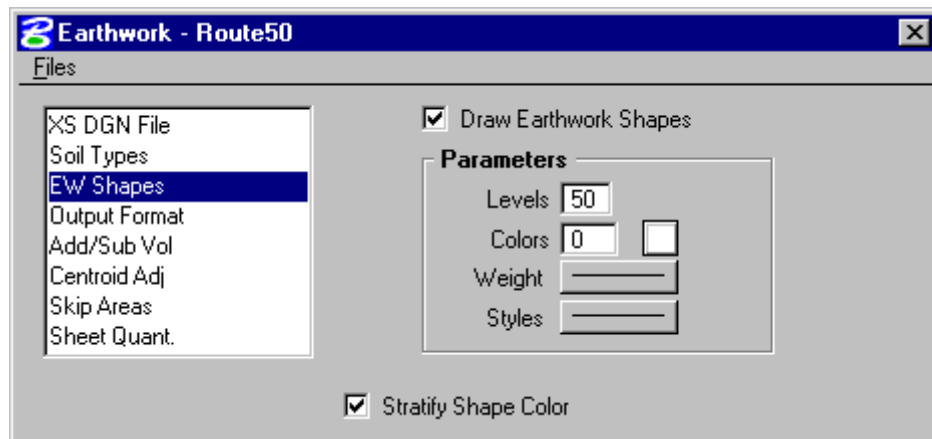
As can be seen from the above examples, when the soil types for the Existing Ground and Proposed Finish Grade classifications were named differently, both soil types appeared in the output. When the soil types for the Existing Ground and Proposed Finish Grade classifications were named the same, the quantities for each classification were combined into one soil type. By paying close attention to the soil types, the user can specify exactly where a specific soil type should be placed.

Once the **Classification** and **Soil Type** are chosen, the user can select the **Element Symbology** to define that particular **Soil Type** and the **Multiplication Factors** for the **Soil Type**. The **Match** button can be used to select the **Element Symbology**. Once the **Match** button is selected, the user can select the elements in the Microstation view. The symbology of that element will be added to the list of symbologies to be used to define the **Soil Type**.

After the user selects the soil type symbologies, the **Add** button needs to be selected to add this soil type to the **Soil Type Items** list. The items in this list can be modified or deleted by selecting the soil type item, making the changes, then selecting the **Modify** or **Delete** buttons.

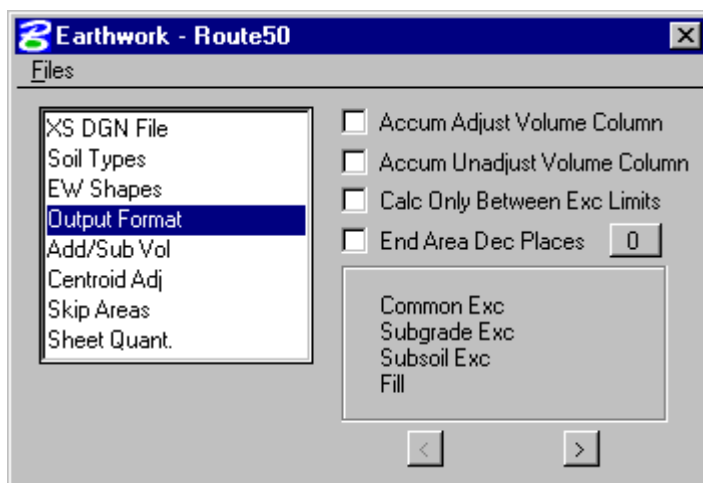
17.3.3 EW Shapes

EW Shapes allows the earthwork shapes to be drawn and specifies the symbology to draw them with. The colors of the earthwork shapes can be stratified, so that each soil type is a different color.



17.3.4 Output Format

Output Format allows the user to specify which items to show in the earthwork report. As the < > buttons are pressed, the Common Excavation, Subgrade Excavation, and Subsoil Excavation are combined into a single quantity.



Common Excavation volumes are not backfilled with an earthwork material. This includes the excavation required for cut sections as well as for pavement thickness, shoulder thickness, etc.

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Subgrade excavation volumes are backfilled with an earthwork material.

Subsoil excavation - excavation required to remove unsuitable material down to the bottom of the proposed template.

Accum Adjust Volume Column will add a column to the earthwork quantities report to show the accumulated adjusted volume. This provides a running total for the adjusted volumes.

Accum Unadjust Volume Column will add a column to the earthwork quantities report to show the accumulated unadjusted volume. This provides a running total for the unadjusted volumes.

Calc Only Between Exc Limits will calculate the earthwork only between the excavation limit lines as specified in the **Soil Types** section. This can be used to calculate earthwork quantities for staged construction, individual roadbeds in a multiple roadbed section, etc.

End Area Dec Places sets the number of decimal places to display in the earthwork quantities report.

17.3.5 Add/Sub Vol

Add/Sub Volumes allows the user to enter positive or negative add volumes. The user can specify whether to add excavation or fill, the soil type, the station, and the volume to be added.

The screenshot shows the 'Earthwork - Route50' application window. On the left is a 'Files' list with options: XS DGN File, Soil Types, EW Shapes, Output Format, Add/Sub Vol (highlighted), Centroid Adj, Skip Areas, and Sheet Quant. The main area has a checkbox 'Process Add/Subtract Volumes' which is checked. Below it is a table with columns 'Class', 'Soil Type', 'Station', and 'Volume'. The table contains one entry: 'Common Exc', 'ClassA', '457+25', and '135'. At the bottom, there are input fields for 'Soil Type' (set to 'ClassA'), 'Station' (set to '457+25'), and 'Volume' (set to '135'). There are also buttons for 'Add', 'Delete', and 'Modify'. An 'EW Operation' dropdown is set to 'Common Exc'.

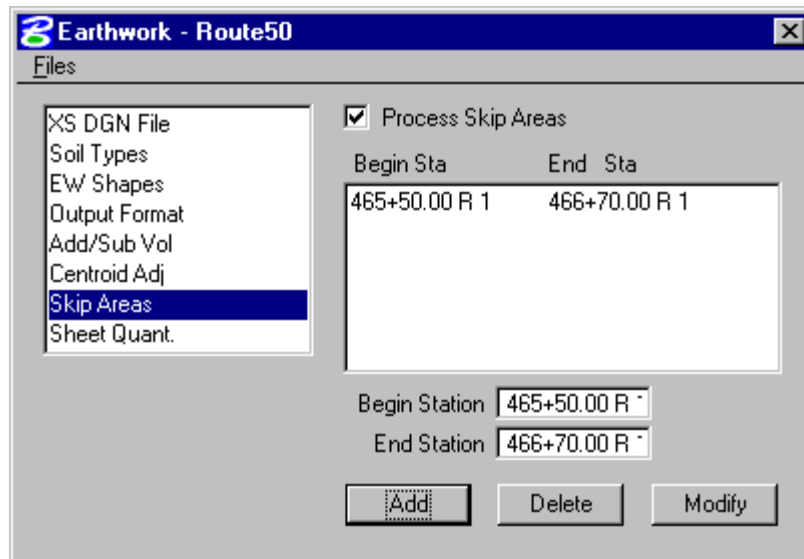
Class	Soil Type	Station	Volume
Common Exc	ClassA	457+25	135

17.3.6 Centroid Adj

Centroid Adjustment allows the user to use the measurement between the centroids of the endarea as the distance between sections instead of the centerline distance. MoDOT does not use the **Centroid Adjustment** method of calculating endarea volumes except in areas where there are extremely deep cuts or high fills.

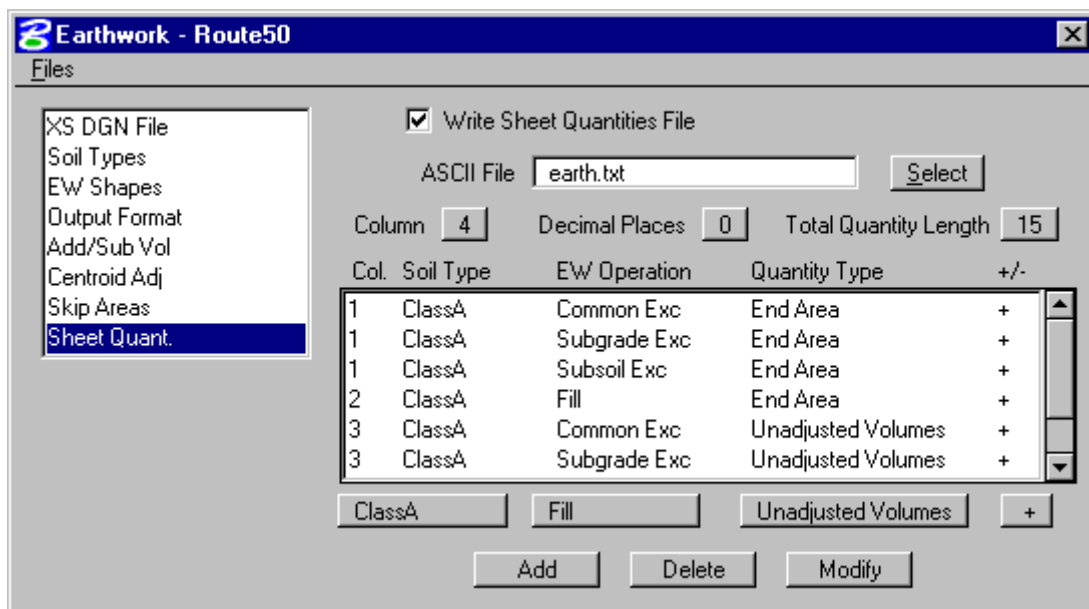
17.3.7 Skip Areas

Skip Areas allows a user to specify an area (i.e. bridge exception) in which to not calculate earthwork volumes. The user needs to specify the **Begin Station** and **End Station** of the **Skip Area**.



17.3.8 Sheet Quant.

Sheet Quantities allows a user to write an earthwork quantity file to be used when plotting the cross-section sheets.



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The name of the ASCII file can be chosen or entered. The user then selects the columns in which to place the quantity, the number of decimal places, the total column width, the soil type, the earthwork operation, and the type of quantity.

For MoDOT, the cross section sheets are set up to plot the information in the proper location on the cross section sheets, the quantities should be set up as follows.

<u>Column</u>	<u>Soil Type</u>	<u>EW Operation</u>	<u>Quantity Type</u>	<u>+/-</u>
1	ClassA	Common Exc	Endarea	+
1	ClassA	Subgrade Exc	Endarea	+
1	ClassA	Subsoil Exc	Endarea	+
2	ClassA	Fill	Endarea	+
3	ClassA	Common Exc	Unadjusted Volumes	+
3	ClassA	Subgrade Exc	Unadjusted Volumes	+
3	ClassA	Subsoil Exc	Unadjusted Volumes	+
4	ClassA	Fill	Unadjusted Volumes	+

If Class C quantities are being shown on the cross section sheets, the following columns should be added.

<u>Column</u>	<u>Soil Type</u>	<u>EW Operation</u>	<u>Quantity Type</u>	<u>+/-</u>
5	ClassC	Common Exc	Endarea	+
5	ClassC	Subgrade Exc	Endarea	+
5	ClassC	Subsoil Exc	Endarea	+
6	ClassC	Common Exc	Unadjusted Volumes	+
6	ClassC	Subgrade Exc	Unadjusted Volumes	+
6	ClassC	Subsoil Exc	Unadjusted Volumes	+

This information is written to the ASCII file, and can be used to plot the quantities on the cross-section sheets. The process of plotting this data on the cross section sheets is covered in more detail in Chapter 14.

17.3.9 File Menu

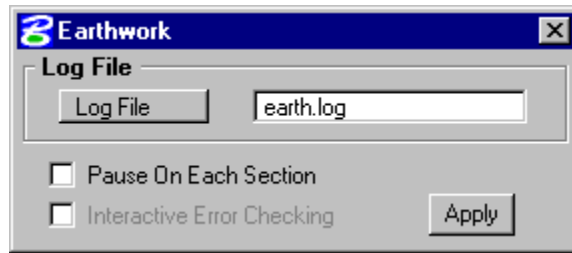


From the **Files** menu, the **Run** option will process all parameters that have been set in the **Earthwork** dialog box. The **Save Settings** option will save all information in the **Earthwork** dialog box. The **Export** option will allow the user to save the parameters in the **Earthwork** dialog box as an ASCII input file. The **Exit** option will exit the **Earthwork** dialog box.

17.3.10 Process Cross Sections

After all necessary information has been entered the user has two options. The preferred method of running the earthwork is to select the **Run** option. The following dialog box will appear and the user may proceed by entering a log file name, choosing the **Pause On Each Section** option

and then selecting the **Apply** button. The second method is to export the information as an ASCII input file, then use the **Process Cross Sections** tool.

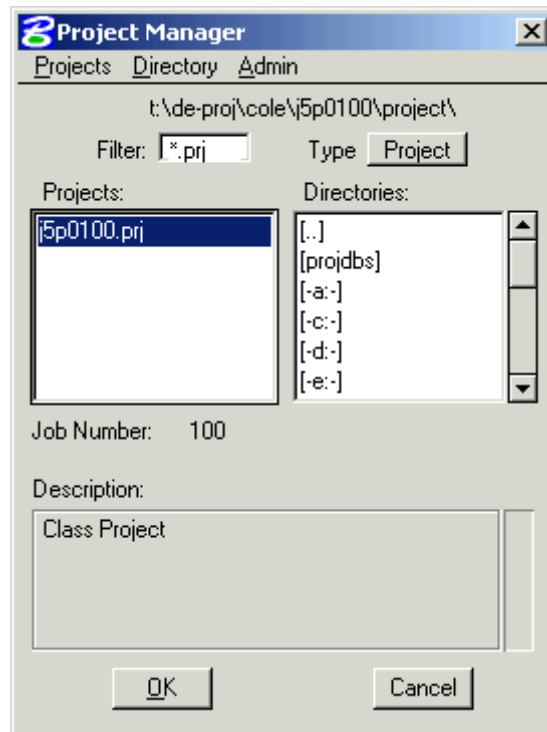


When processing the earthwork quantities, a .log file should be created. This ASCII file will contain the earthwork quantities that the user will use to evaluate the earthwork.

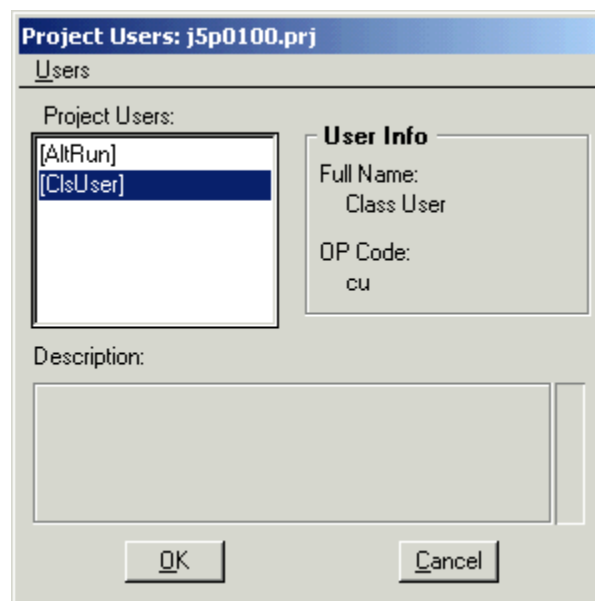
17.4 Example 17-1

1. Open the Microstation file
t:\de-proj\cole\5p0100\data\rte50_xs_j5p0100.dgn.

2. Open the project **t:\de-proj\cole\5p0100\project\j5p0100.prj.**

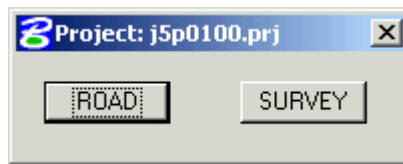


3. Select the user **ClsUser**.



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4. Enter **Road**.

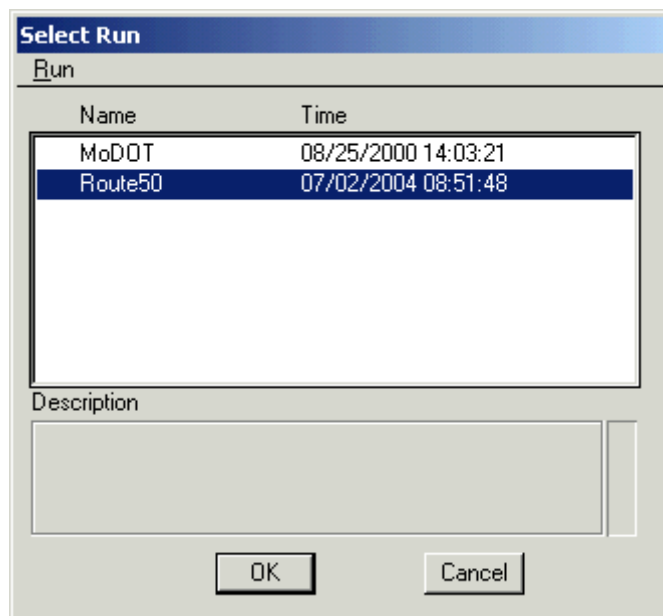


5. Select the **Route50** working alignment.

6. Choose **Earthwork** from the **Road Project** dialog.

Earthwork

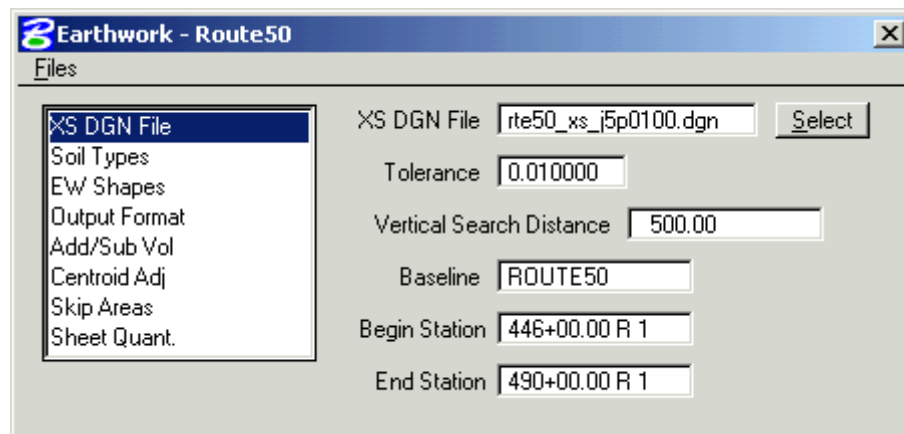
Copy the **MoDOT** run to **Route50**, and open the **Route50** run.



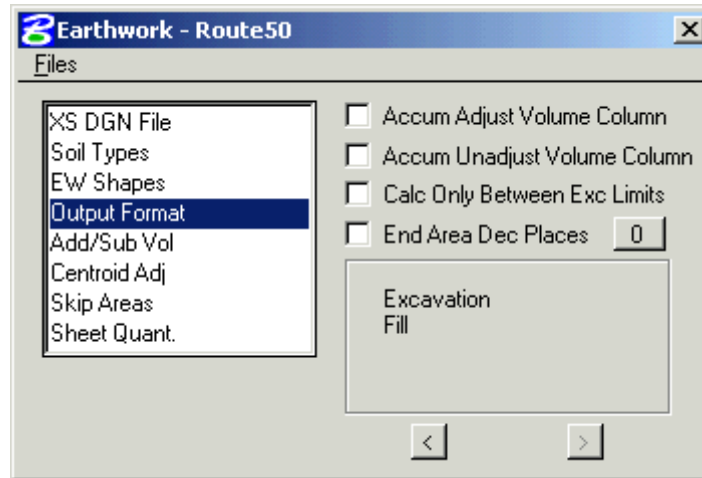
7. Be sure the following items are set in the **XS DGN File** sections of the dialog:

XS DGN File: **rte50_xs_j2p0200.dgn**

Baseline: **ROUTE50**

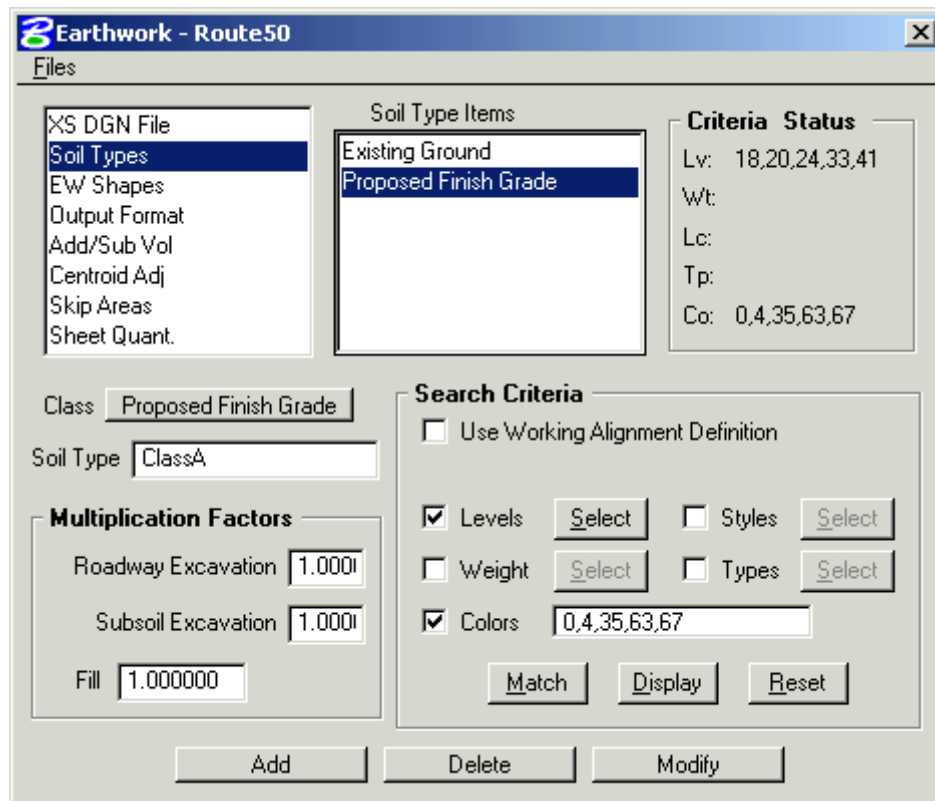


8. In the **Output Format** section of the dialog, set the format to **Excavation** and **Fill**:



9. In the **Soil Types** section create the following **Soil Type Items**.

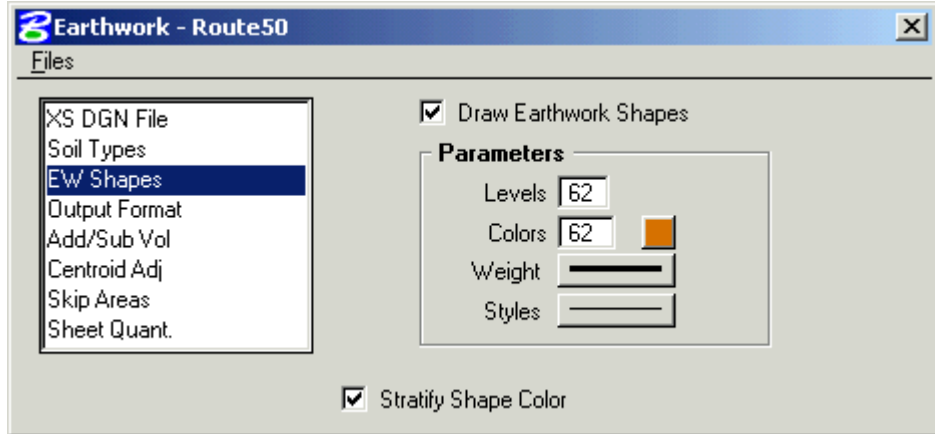
<u>Class</u>	<u>Soil Type</u>	<u>Search Criteria</u>
Existing Ground	ClassA	Level = 57 Color = 90
Proposed Finish Grade	ClassA	Level = 18,20,24,33,41 Color = 0,4,35,63,67



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10. Toggle on **Draw Earthwork Shapes** and **Stratify Shape Color** in the **EW Shapes** section. Set the following **EW Shapes** parameters as shown:

Levels 62
Colors 62
Weight 4
Styles 0 (Solid Line)



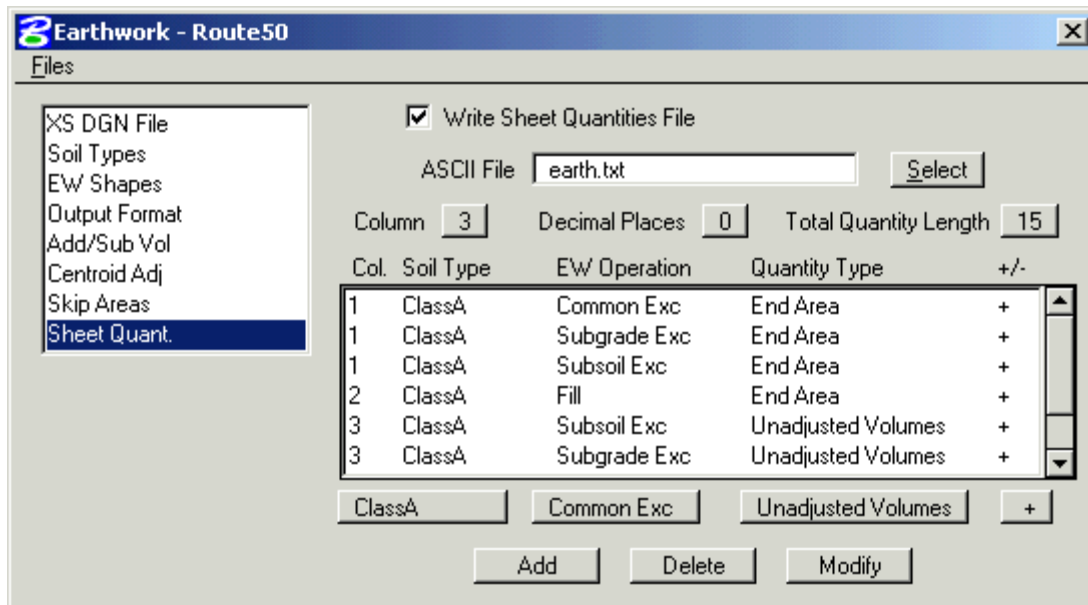
11. In the **Sheet Quant.** Section, toggle on the **Write Sheet Quantities File**.

ASCII file: **earth.txt**

Decimal Places: **0**

Total Quantity Length: **15**

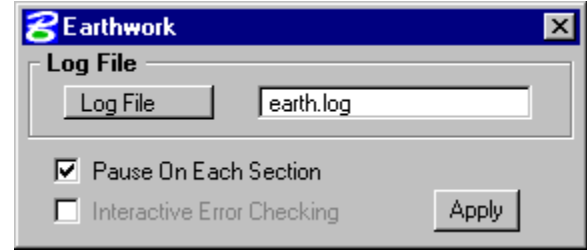
<u>Col.</u>	<u>Soil Type</u>	<u>EW Operation</u>	<u>Quantity Type</u>	<u>+/-</u>
1	ClassA	Common Exec	Endarea	+
1	ClassA	Subgrade Exec	Endarea	+
1	ClassA	Subsoil Exec	Endarea	+
2	ClassA	Fill	Endarea	+
3	ClassA	Common Exec	Unadjusted Volumes	+
3	ClassA	Subgrade Exec	Unadjusted Volumes	+
3	ClassA	Subsoil Exec	Unadjusted Volumes	+
4	ClassA	Fill	Unadjusted Volumes	+



12. Save the settings for the dialog.

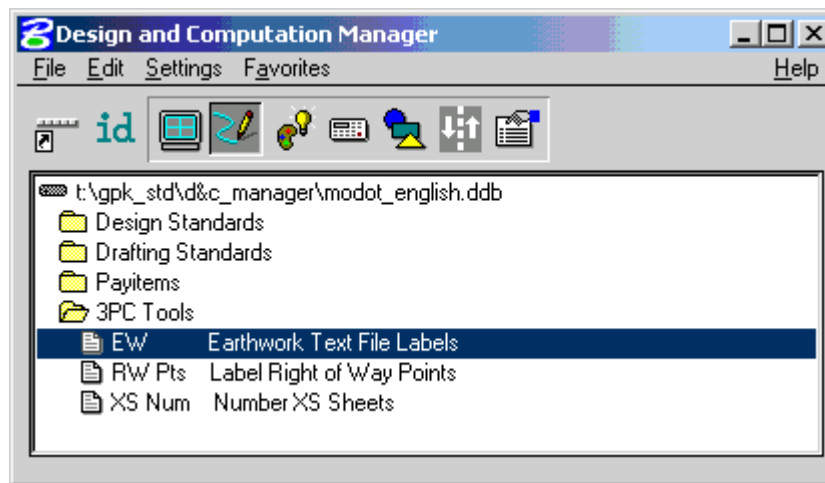
13. Run the proposed cross-sections.

Set the **Log File** option to **Log File**, and name the log file **earth.log**.

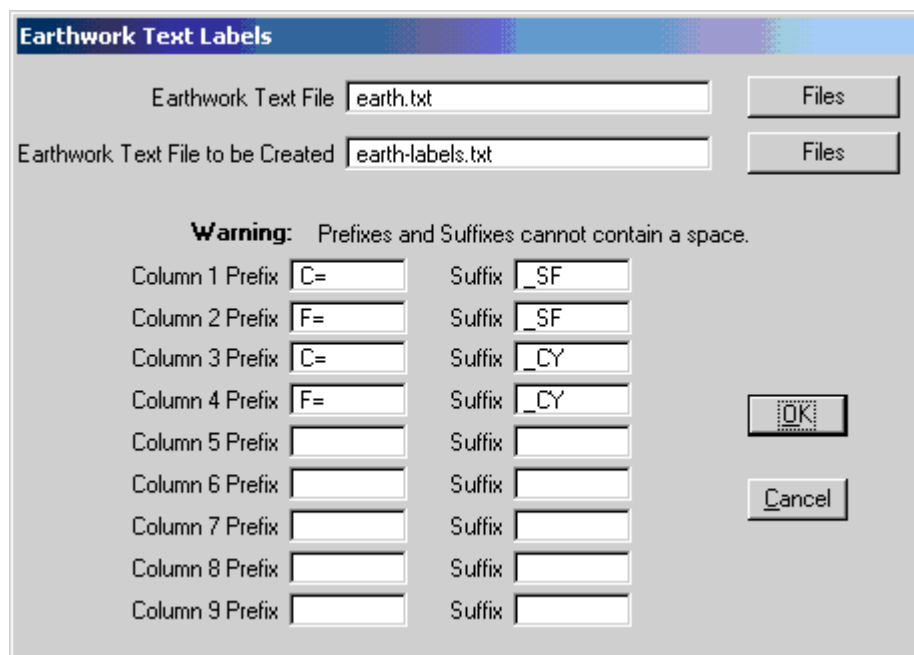


14. Review the **earth.log**, and the **earth.txt** files.

15. To add the labels to the earth.txt file, open **Design and Computation Manager**. Navigate to **3PC Tools** and double click on **EW Earthwork Text File Labels** as shown in the following figure.



This will open the following dialog. Fill it out as shown and press OK.



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16. Review the **earth-labels.txt** file.

17. Save the changes to the MicroStation DGN.

Exit D&C Manager.

Exit the run and exit the Earthwork dialog.